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Indian Standard

MULTI-OPERATOR TYPE ARC WELDING TRANSFORMERS- SPECIFICATION

UDC 621·314·21 : 621·791·75

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NEW DELHI 110002

September 1992

Price Group 6

Electric Welding Equipment Sectional Committee, ETD 21

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Electric Welding Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

In the preparation of this standard, assistance has been derived from the following:

BS 635 : 1979 'Arc welding power sources, equipment accessories', issued by the British Standards Institution (BSI).

IEC Doc: 26 (Central Office) 19-I-11 'Draft -Safety requirements for arc welding equipment — Power sources', issued by the International Electrotechnical Commission (IEC).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of singnificant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

MULTI-OPERATOR TYPE ARC WELDING TRANSFORMERS- SPECIFICATION

1 SCOPE

1.1 This standard lays down the requirements of construction and methods of test for oil cooled three phase transformers of the flat characteristic type (substantially constant voltage) for manual multiple metal arc welding and associated current regulators.

1.2 This standarddoes not apply to conventional single/double operator transformers and transformer rectifier sets for manual multiple metal arc welding.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	Title
2026 (Part 4):1977	Power transformers : Part 4 Terminal marking tappings and connections (*first revision*)
2834 : 1986	Shunt capacitors for power systems (*second revision*)
8804 : 1978	Plugs, sockets and terminal arrangements for manual arc welding equipment

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Manual Metal Arc Welding (Hand Welding)

Metal arc welding with consumable electrodes not exceeding 460 mm in length and applied by the operator without automatic or semi-automatic means of replacement.

3.2 Multiple Metal Arc Welding Power Source

A power source capable of supplying current simultaneously to three or more operators through suitable regulator engaged in manual metal arc welding without objectionable arc interactions.

3.3 Duty Cycle

The ratio of time during which the regulator on the output side of' the power source is-loaded to the total time of a complete cycle expressed in percentage. In this standard, the cycle duration is 5 minutes.

3.4 Rating

A statement of limitation of performance parameter under specified operating conditions assigned by the manufacturer

3.5 Open Circuit Voltage

The output voltage exclusive of any arc stabilizing, or arc striking voltage across the neutral and any phase of the transformer ready to weld but carrying no welding current.

3.6 Rating Welding Current

a) The maximum continuous hand welding current for regulators, and

b) The continuous test current for the power source.

3.7 Maximum Continuous Hand Welding Current

The minimum current which may be drawn through the current regulator at the conventional load voltage and at the rated duty cycle without exceeding the stated temperature rise.

3.8 Maximum Hand Welding Current

The maximum current obtainable through the regulator at the conventional load voltage.

3.9 Minimum Hand Welding Current

The minimum current obtainable through the regulator at the conventional load voltage.

3.10 Conventional Load Voltage

The voltage measured between the output terminal of the regulator and the 'work' return terminal (Neutral) of the transformer when a specified current is flowing through a conventional load.

3.10.1 The conventional load voltage for metal arc welding is given in Table 1.

3.11 Conventional Load

A practically non-inductive resistive load having a power factor of 0·99 or more.

3.12 Continuous Test Current

Current to be drawn continuously from the power source or through the regulator when being tested for temperature rise.

Table 1 Welding Current and Welding Load Voltage

(*Clauses* 3.10.1, 8.9.1 *and* 8.9.2)

Load Current	Conventional Load Voltage
(1)	(2)
A	*V*
100	24
150	26
200	28
300	32
400	36
500	40
600 and above	44

NOTE — These load voltages are based upon the formula $E = 20 + 0{\cdot}04\,I$, where E is the load voltage and I is the load current. For currents above 600 A load voltage remains constant at 44 V.

3.13 Rated Number of Operators

The number of operators which the power source can supply at the rated welding current per operator.

3.14 ‘Diversity Factor

The factor used to multiply the product of the number of operators and the maximum continuous hand welding current (rated current) per operator to give an equivalent current which does not exceed the value of the rated welding current of the power source (*see* Table 2).

Table 2 Diversity Factors for Transformer

No. of Operators per Phase	Diversity Factor
(1)	(2)
1	0.60
2	0’50
3	0’45
4	0’425
5	0’40
6	0’39
7	0·38
8	0·37
9	0·36
10	0’35

3.15 Type Test

Test made on a power source or a regulator which is representative of other power sources or regulators identical in rating and construction to demonstrate that they comply with the specified requirements not covered by tests to which each individual set is subjected.

3.16 Routine Test

A test carried out on each power source or the regulator to show that it has been assembled correctly and is in sound working order both electrically and mechanically.

4 RATING

4.1 Transformer Power Source

4.1.1 *Input Voltage*

The rated input voltage of the power source shall be 415 V 3 phase 50 Hz. Primary tappings shall be provided for 390 V and 440 V.

The windings shall be connected delta-star Vector group symbol Dy 11 as given in IS 2026 (Part 4): 1977.

4.1.2 *Open Circuit Voltage*

The rated open circuit voltage shall be 90 V between any phase and neutral.

NOTE — Higher value of open circuit voltage not exceeding 100 V shall be a matter of agreement between the purchaser and the manufacturer.

4.1.3 *Continuous Rating*

The preferred continuous kVA rating of the transformer shall be as shown in Table 3 depending on the number of operators per phase at 350 A per operator.

Table 3 Preferred Continuous kVA Rating of Transformer

Number of 350 A Operator per Phase	Continuous kVA Rating
(1)	(2)
1	57
2	95
3	128
4	160

4.1.3.1 The kVA rating given in Table 3 are calculated as under:

$$\text{Continuous kVA rating} = \frac{N \times A \times V \times n \times D}{1\,000}$$

where

N = number of operators per phase,

A = current per operator (350 A),

V = open circuit volt per phase,

n = number of phase (three), and

D = diversity factor.

NOTE — Diversity factor for different number of operator is given in Table 2.

4.1.4 *Rated Welding Current*

The rated welding current of the transformer per phase shall be the continuous test current per phase and is given in Table 4.

Table 4 Rated Welding Current of Transformer

(*Clause* 4.1.4)

Continuous kVA Rating (1)	Continuous Test Current in Ampere per Phase (2)
57	200
95	350
128	480
160	600

4.2 Series Current Regulators

4.2.1 *Rated Open Circuit Voltage for Current Regulators*

The current regulators shall be suitable for use in conjunction with a power source having rated open circuit voltage of 90 V.

4.2.2 *Rated Welding Current*

The rated welding current of the regulator shall be the maximum continuous hand welding current.

4.2.2.1 There will be four sizes of current regulators having the rated current as under:

210 A, 350 A, 450 A and 600 A

4.2.3 *Number of Operator per Phase*

The number of operators per phase of different sizes of transformers are given in Table 5.

Table 5 Number of Operator per Phase

Transformer Continuous Rating kVA	Number of Operator per Phase			
	210 A	350 A	450 A	600 A
(1)	(2)	(3)	(4)	(5)
57	2	1	—	--
95	4	2	1	1
128	5	3	2	1
160	7	4	3	2

4.2.4 *Maximum Hand Welding Current*

The maximum hand welding current shall be the same as the rated current of the regulator.

4.2.5 *Minimum Hand Welding Current*

The minimum hand welding current shall be not more than 20 percent of the rated current.

4.3 Limits of Temperature Rise

The maximum temperature rise shall be as shown in Table 6.

Table 6 Limits of Temperature Rise

Part	Method of Cooling	Method of Measurement	Temperature Rise °C
(1)	(2)	(3)	(4)
Winding (all classes of insulation)	Oil forced or Natural	Resistance Thermometer	60 65
Top oil	—	Thermometer	55
Core and other parts	—	Thermometer	Not to exceed the value that will injure the core itself or the adjacent materials

5 DUTY CYCLE

The rated duty cycle at maximum continuous hand welding current shall be 60 percent. A complete cycle consists of 3 minutes of load period followed by 2 minutes of no load operation.

6 DESIGN AND CONSTRUCTION

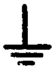
6.1 Transformer Power Source

6.1.1 The transformer power source shall be of substantially flat characteristic. The regulation (the difference between the no load secondary voltage and the secondary voltage) at rated current and 0·35 p f. lagging shall not exceed 3 percent of the no load secondary voltage.

6.1.2 The power source shall be double wound and the secondary or the output terminals shall be insulated from the tank. The terminals shall be marked in accordance with IS 2026 (Part 4) : 1977.

6.1.3 *Earthing*

Two earthing terminals of at least 50 mm^2 section, each shall be provided where all metal parts of the equipment likely to become charged accidentally, shall be connected. The earthing terminals shall be protected against corrosion and shall be indelibly marked with the following symbol



6.1.3.1 These terminals shall not be used for any other purpose (such as clamping two parts of the casing together).

6.1.4 The following are the general requirements of the power source:

a) Enclosure or the tank shall be suitable for outdoor operation;

b) The secondary and the neutral shall be insulated from the tank;

c) Suitable means for anchoring both the incoming and outgoing cables shall be provided;

d) Output terminals shall be suitably shrouded to avoid accidental or inadvertent contact;

e) Primary terminals shall be suitably covered so that these are not accessible to unauthorised persons;

f) An oil conservator shall not be provided;

g) A thermometer pocket shall be provided;

h) Provision shall be made so that oil level may be checked easily;

j) Lifting hooks or suitable provisions for lifting shall be provided;

k) Output terminals shall be of the busbar type and suitable for bolts as indicated in Table 7;

n) The output terminals shall be suitable for accommodating cable sockets equal in number to the number of 350 A operators per phase plus one per phase on three operator transformers and two per phase on six, nine and twelve operator transformers so that additional distribution boxes may be fed at reduced currents, if required; and

p) Drain plug or drain valve shall be provided.

Table 7 Dimensional Details of Output Terminals of Transformers Power Source

(*Clause* 6.1.4)

Transformer Continuous Rating	Sectional Area of Busbar (Copper) mm^2	Bolt Size mm	No. of Cable Socket to be Accommodated
(1)	(2)	(3)	(4)
57	125	10	2
95	200	12	3
128	275	12	5
160	325	16	6

6.2 Series Current Regulators

6.2.1 In case when output current is controlled by means of tappings, the number of current setting positions in the range shall be not less than 30.

6.2.2 Provisions shall be made for visual indication of the output current setting in amperes.

6.2.3 The series current regulator shall be provided with terminals in accordance with IS 8804 : 1978. Sockets shall not be used.

6.2.4 The terminals shall be suitably shrouded to avoid accidental or inadvertent contact.

6.2.5 The enclosure or the tank shall be suitable for outdoor operation.

6.2.6 Provision for earthing shall be made as in 6.1.3.

6.2.7 Wheels shall not be provided.

6.2.8 Provision shall be made for lifting the regulator.

6.2.9 Oil drain plug shall be provided.

6.2.10 Provision shall be made so that oil level may be checked easily.

7 POWER FACTOR CORRECTION CAPACITORS

7.1 A capacitor may be used to improve the power factor to approximately 0·85 lagging at 50 percent of the rated welding current of the power source.

7.2 The capacitor, if used, shall be so connected that it is switched off with the transformer.

7.3 The capacitor, if used, shall conform to IS 2834 : 1986.

7.4 The rating in KVar of the capacitor to be used with different sizes of the transformer power source shall be in accordance with Table 8.

Table 8 KVar Rating of Capacitor to be Used with Different Sizes of Transformer

Transformer Continuous Rating (kVA)	KVar Rating of Capacitor
(1)	(2)
57	16·5
95	30
128	45
160	till

8 TESTS

8.1 Test Conditions

8.1.1 The tests specified in this standard shall be carried out at the manufacturer's works and shall be made on a new dry and completely assembled power source or a regulator.

8.1.2 Tests shall be made at an ambient air temperature between 10°C and 40°C.

8.1.3 Ventilation shall be identical with that prevailing under normal service conditions. The measuring device used shall not interfere with the normal ventilation of the welding power source or the regulator or cause of transfer of heat to or from it.

8.1.4 The accuracy of measuring instrument shall be as under:

a) Electrical measuring instrument	Class 1·0
b) Thermometers	± 0 5°C
c) Thermocouples or resistance thermometers	± 0·5°C

8.1.5 The tests fall into two categories:

a) Type tests, and

b) Routine tests.

8.2 Type Tests

They shall be made on one power source or regulator of each type or design *or size* to show that it complies with all the requirements of this standard.

The records of type tests on a power source or a regulator which in essential details is representative of the one being purchased, produced by the manufacturer shall be accepted by the purchaser or his representative as evidence of type test instead of actual test.

The presence of the purchaser or his representative during the tests shall be a matter of special agreement between the purchaser and manufacturer.

8.2.1 *Transformer Powtr Source*

Type tests and their sequence shall be as follows:

a) Insulation resistance test (see 8.4), preliminary check,

b) Open circuit voltage test (see 8.5),

c) Temperature rise test (see 8.6),

d) Test for voltage regulation (see 8.8),

e) High voltage test (see 8.7), and

f) Insulation resistance test (see 8.4).

8.2.2 *Series Current Regulators*

Type tests and their sequence shall be as follows:

a) Insulation resistance test (see 8.4), preliminary check;

b) Voltage drop test or load characteristic test (see 8.9);

c) Temperature rise test (see 8.6);

d) High voltage test (see 8.7); and

e) Insulation resistance test (see 8.4).

8.3 Routine Test

These shall be made on each power source or current regulator to show that the set is assembled correctly and is in sound working order both electrically and mechanically and complies with all the requirements of this standard.

A certificate of routine test shall be furnished by the manufacturer which shall show that the power source or the current regulator has been subjected to all the tests listed under 'Routine Test'. If values derived from type tests are included, these shall be so designated.

8.3.1 *Transformer Power Source*

Routine tests and their sequence shall be as follows:

a) Insulation resistance test (see 8.4), preliminary check;

b) Open circuit voltage test (*see* 8.5);

c) High voltage test (see 8.7); and

d) Insulation resistance test (see 8.4).

8.3.2 *Series Current Regulator*

Routine tests and their sequence shall be as follows:

a) Insulation resistance test (see 8.4), preliminary check;

b) Voltage drop test or load characteristic test (see 8.9);

c) High voltage test (see 8.7); and

d) Insulation resistance test (see 8.4).

NOTE — **The preliminary check on insulation resistance at room temperature is required to ensure that the subsequent tests may be carried out on the set safely.**

8.4 Insulation Resistance Test

8.4.1 Insulation resistance shall be measured by the application of a dc voltage not less than 500 V and shall be of not less than the values indicated below:

	Insulation Resistance (Preliminary Check)	*Insulation Resistance After Temperature Rise Test and HV Test*
a) Between primary winding and secondary winding of the power source	5 MΩ	2 MΩ
b) Between primary winding and earth or casing of the power source	2·5 MΩ	2 MΩ
c) Between secondary winding and earth or casing of the power source	2 MΩ	1·5 MΩ
d) Between the winding and the casing of the series current regulator	2 MΩ	1·0 MΩ

NOTE — Capacitors used to improve power factor shall be disconnected during this test.

8.5 Open Circuit Voltage Test

The primary terminals of the power source shall be connected to a supply voltage of 415 volts, 3 phase 50 Hz with its output side open circuited. The open circuit voltage shall be measured and shall be within ± 5 percent of the declared value.

8.6 Temperature Rise Test

8.6.1 The test shall be conducted at an ambient temperature between 10°C to 40°C and at an altitude not exceeding 1 000 m.

8.6.2 *Limits of Temperature Rise*

The limits of temperature rise shall be as indicated in 4.3.

8.6.3 *Measurement of Temperature*

The measurement of temperature shall be done either by resistance method (*see* **8.6.4**) or by thermometer method (*see* **8.6.5**).

8.6.4 *Resistance Method*

In this method temperature of a winding T_2 at the end of the test period is calculated from its measured resistance R_2 at that temperature and its measured resistance R_1 at some other temperature T_1 using the formula:

$$T_2 = \frac{R_2}{R_1} (K + T_1) - K$$

where

T_2 and T_1 are measured in degree celsius.

K = 235 for copper and 225 for aluminium;

R_2 = Resistance in ohms at temperature T_2; and

R_1 = Resistance in ohms at temperature T_1.

8.6.5 *Thermometer Method*

In this method temperature is measured by a thermometer applied to the accessible surface or other parts where maximum temperature is likely to occur.

8.6.6 If the resistance of the winding is 0·005 ohms or below or the resistance of the joints, connections and tapping with moving contacts constitutes a considerable part of the total resistance the resistance method of temperature measurement is likely to be inaccurate. In such cases, the temperature rise at the end of the test shall be determined as follows:

> The top oil temperature shall be measured by a thermometer placed in a thermometer pocket. The temperature rise to be determined shall not exceed the limit for oil given in 4.3.

8.6.7 Measurement of temperature by both methods shall not be used. One method only shall be shown to determine the temperature of any particular part.

8.6.8 *Determination of Temperature Rise*

a) For windings by means of the resistance method or by the thermometer method (*see* **8.6.6**),
b) For other parts by means of thermometer, and
c) For oil by means of thermometer placed as near as possible to the top level of oil in the tank or by placing the thermometer in the thermometer pocket if provided.

8.6.8.1 The temperature rise of a component is the difference between the temperature of that component at the end of the test period and the measured ambient temperature (*see* **8.6.9**).

8.6.9 *Measurement of Ambient Temperature*

The ambient temperature shall be determined by means of three thermometers spaced uniformly around and at a level approximately half way up the cooling surface at a distance 1 to 2 n from the equipment. The means of the readings of the three thermometers shall be taken as the ambient temperature.

8.6.9.1 If the ambient temperature varies appreciably during the test, the mean of the three thermometer readings taken at equal intervals during the last quarter of the duration of the test.

8.6.9.2 Alternatively, a thermometer is placed centrally in glass beaker 100 to 125 mm in diameter filled with transformer oil up to a depth of 100 mm with its bulb 50 mm below the top surface of the oil. The thermometer is then placed as described in **8.6.9**. The mean of the readings taken during the last quarter of the duration of the test shall be taken as the ambient temperature.

8.6.10 *Duration of Test*

The test shall be continued until one of the following requirements has been met. The method to be followed shall be chosen by the manufacturer.

8.6.10.1 The test shall be regarded as completed when the temperature rise does not exceed 2°C in 1 hour. Then the method shown in Fig. 1 shall be employed for the determination of the final temperature rise.

8.6.10.2 The test shall be regarded as completed when the top oil temperature rise does not vary by more than 1°C per hour during four consecutive hourly readings.

8.6.11 *Temperature Correction for Cooling of the Equipment After Shut Down*

If the winding temperature is measured by taking resistance method after the shut down of the equipment a suitable correction shall be applied so as to obtain as nearly as practicable the temperature of the winding at the instant of turning off the power.

For this purpose, the hot resistance reading and the time from shut down to measurement shall be recorded.

8.6.11.1 *Correction factors*

If the load loss in the winding does not exceed 8 watts per kg of copper or 2·5 watts per kg of aluminium no correction is necessary if the measurement is done within 2 minutes after shut down. But if the measurement is done after 2 minutes then correction shall be made according to 8.6.11.2.

8.6.11.2 If the load loss in the winding exceed 8 watts per kg of copper or 2·5 watts per kg of aluminium but does not exceed 66 W per kg of copper: or 20 W per kg of aluminium the correction in degrees celsius (to be added to the measured) temperature shall be the product of the loss in watts per kg of the conductor multiplied by the correction factor given in Table 9.

8.6.12 *Testing Methods*

At the choice of the manufacturer, any one of the following methods shall be used for transformers:

a) Short circuit method (8.6.13),

b) Back to back method (8.6.14), and

c) Direct loading on an external adjustable resistance reactance (8.6.15), and for regulators (8.6.16).

8.6.13 *Short Circuit Method of Temperature Rise Test*

In this method, the total losses (taken as the sum of the measured load loss at rated current corrected to 75°C and the measured no load loss) are supplied to the transformer windings. This condition is maintained for a period indicated in 8.6.10. At the end of this period, the top oil temperature is recorded. The input power is then reduced to a value which results in the circulation of rated current at rated frequency in the windings and this value is maintained for 1 hour. The top oil temperature and the resistance of the windings are then recorded again. The temperature rise of the windings shall be taken as the sum of the temperature rise of windings, calculated from resistance measurement plus the difference between the first and second top oil temperature.

8.6.14 *Back to Back Method of Temperature Rise*

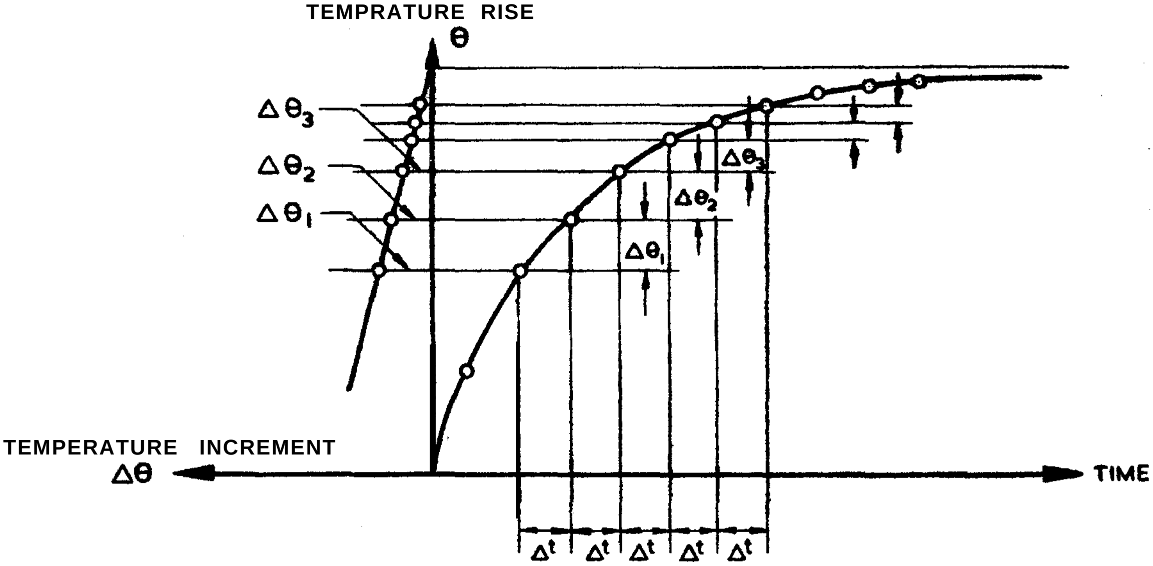
In this method, rated currents and rated exciting voltages are applied to the transformer under test. The test is continued in terms of 8.6.10, the final oil temperature and the resistance of the windings are recorded. The temperature rise of windings are calculated from the measured values.

8.6.15 *Direct Loading Method of Temperature Rise Test*

In this method, rated load is applied to the transformer windings and the test is continued for a period indicated in 8.6.10. The oil temperature and resistance of windings are recorded.

8.6.16 *Temperature Rise 'Test of Regulator*

The regulator shall be set at its maximum current setting. A continuous test current is passed through the regulator for a period indicated in 8.6.10 at the end of which oil temperature and resistance of winding shall be recorded. The temperature rise of oil and winding is calculated from these recorded values, The continuous test current shall be the rated current multiplied by 0·6.



(Equal Time Intervals)

FIG. 1 METHOD FOR DETERMINATION OF FINAL TEMPERATURE RISE OF OIL

Table 9 Correction Factors

(*Clause* 8.6.11.2)

Time in Minutes from Shut Down to Measurement	Copper	Aluminium
(1)	(2)	(3)
1	0·09	0·032
1·5	0·12	0·045
2·0	0·15	0·064
3·0	0·20	0·091
4·0	0·23	0·113

Intermediate values may be interpolated.

8.7 High Voltage Test

8.7.1 The high voltage test shall be applied once only on a new and completely assembled power source or a regulator. The insulation shall withstand the test voltage without any flashover or breakdown.

8.7.1.1 The ac test voltage obtained from a separate source shall be of approximately sine wave form with a peak value not exceeding 1·45 times the rms value having a frequency between 25 Hz and 100 Hz.

8.7.1.2 The rms value of the applied voltage shall be measured by:

a) a suitable voltmeter connected to the output side of the testing transformer,

b) a voltmeter used with a suitably calibrated voltage transformer, and

c) by a voltmeter used in conjunction with the specially calibrated voltmeter winding on the testing transformer.

8.7.1.3 The test voltage shall be raised to the full value as rapidly as is consistent with its value being indicated by the measuring instrument. The full test voltage shall be maintained for one minute. The test voltage is then reduced to at least one-third of its full value before switching it off.

NOTE — Capacitors, if used to improve power factor, shall be disconnected during this test.

8.7.2 For transformer power source, the test voltage shall be 2 000 rms. This voltage shall be applied to each winding in turn between the winding under test and the remaining windings connected to tank and to earth.

8.7.3 For regulator, the test voltage shall be 1 500 volts rms. This voltage shall be applied between the winding and the tank.

8.7.4 If the high voltage test is to be repeated on a new transformer or a regulator, test voltages shall be 80 percent of the values indicated in 8.7.2 and **8.7.3.**

8.7.5 In case of high voltage tests on a used transformer or regulator, the test voltage shall be 1000 V rms.

8.8 Test for Voltage Regulation

This test is to be conducted on the transformer power source.

8.8.1 The difference between the no load secondary voltage and the secondary voltage at rated current and 0·35 power factor lagging shall not exceed 3 percent of the no load secondary voltage.

8.8.2 The percentage regulation is calculated as follows:

$$\text{Percentage regulation} = 0{\cdot}35\ E_r + 0{\cdot}94\ E_x + \frac{(0{\cdot}35\ E_x - 0{\cdot}94\ E_r)^2}{200}$$

where

E_r = percentage winding loss at rated current, and

E_x = percentage reactance at rated current.

NOTE — Calculation of voltage regulation is shown in Annex A.

8.9 Voltage Drop Test or Load Characteristic Test for Regulators

8.9.1 The voltage drop across current regulators shall be such that when used in conjunction with their respective transformers and with cables as agreed between the manufacturer and the purchaser, the associated load currents and load voltages for different settings of the regulator shall be as shown in Table 1.

8.9.2 *Tolerance*

Tolerance on load current shall be ±10 percent of the set value while load voltage being maintained according to the values shown in Table 1.

9 RATING PLATE

9.1 A clearly and indelibly marked rating plate shall be fixed securely to or printed on each power source or the regulator.

9.1.1 The purpose of the rating plate is to indicate to the user the electrical characteristics of the power source or regulator to enable the correct selection of the power sources or the regulator to be made and to allow comparison with other power sources or regulators.

9.2 The dimensions of the rating plate are not specified and shall be chosen by the manufacturer,

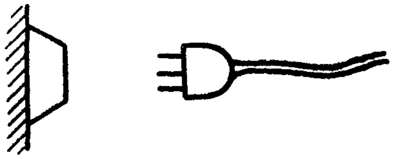
9.2.1 The symbols and captions underlined shall be shown on the rating plate. Those in brackets are for information only.

9.3 The rating plate of the power source and the regulator are shown in Fig. 2 and Fig. 3 respectively.

1) (Manufacturer)	1A) (Trade Mark)
2) *Type*	3) Jvo.
	5) (Standard and year)

6) Welding	7)	10)
	8) *Hz*	11)
	9) *U* V	A

12) Input



13) 14) *Hz*	17) Continuous rating	20)
15) U_1 *V*	18) *A*	21)
16) *kVar*	19) *kva*	22)

FIG. 2 RATING PLATE FOR TRANSFORMER FOR MULTIPLE OPERATOR WELDING

93.1 The rating plate of the power source consists of three sections:

a) The upper section contains the name of the manufacturer and various informations for identification of the power source;

b) The middle section contains all data for the welding circuit; and

c) The lower section contains information regarding the supply of power to the power source.

9.3.1.1 The rating plate of the regulator has the first two sections only with the input (power source OCU,) shown in box number 9.

1) (Manufacturer)	1A) (Trade Mark)
2) *Type*	3) *No.*
4)	5) (Standard and year)

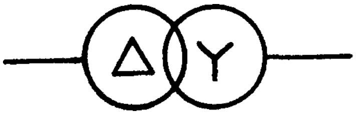
6) Welding	7) *A*/ V *A*/ V	
	8) *Hz*	10) A
	9) U_0 V	*M* mm²

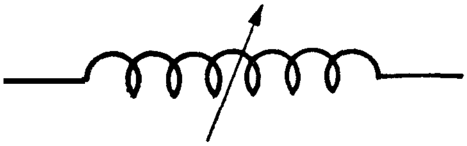
FIG. 3 RATING PLATB FOR REGULATORS

9.3.1.2 The symbols and captions underlined shall be shown on the rating plate. Those in brackets are for information only.

9.4 Contents

a) Box 1	Name and address of the manufacturer Country of origin
b) Box IA	Trade Mark
c) Box 2	Type (identification) of the power source or the regulator as given by the manufacturer or manufacturer's model number or description, etc
d) Box 3	Serial number assigned by the manufacturer
e) Box 4	Type of power sources or the regulator using the symbol

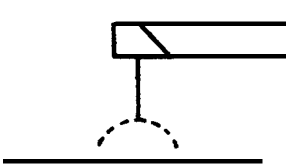




Type of cooling in words

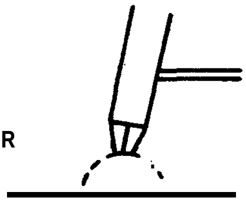
f) Box5 The number and year of this Indian Standard

g) Box 6 Process of welding using the appropriate symbol from the following:



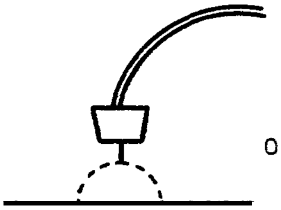
MANUAL METAL ARC

OR



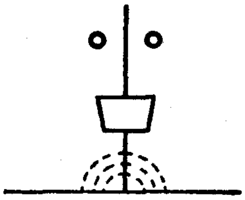
TIG

OR

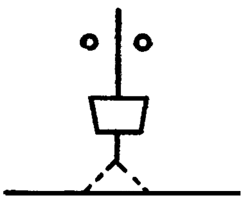


MIG/ MAG

OR

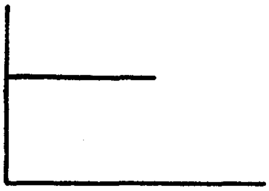


SUBMERGED ARC

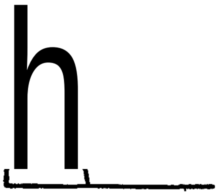


AUTOMATIC OPEN ARC

h). Box 7 Fig. 2 only — The type of the static current voltage characteristic shown by one of the following:



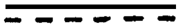
SUBSTANTIALLY CONSTANT VOLTAGE CHARACTERISTIC



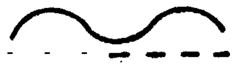
DROOPING VOLTAGE CHARACTERISTIC

j) Box 7 Fig. 3 — Minimum to maximum welding current at appropriate load voltages for the process of welding

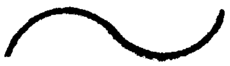
k) Box 8 — The type of welding current indicated in this box by one of the following symbols:



direct current



rectified current



alternating current preceded by the number of phases and **followed** by the frequency in **Hz**

m) Box 9 — The no load voltage U_0 of the power source in volts to be indicated in this box

n) Box 10 Fig. 2 — The rated number of operators is indicated in this box

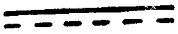
p) Box 10 Fig. 3 — The rated welding current of the regulator in Amperes

q) Box 11 Fig. 2 — The rated welding current per operator in Amperes

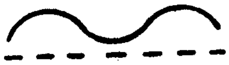
r) Box 11 Fig. 3 — The cable loop length and cross sectional area with which the regulator has been calibrated

s) Box 12 — Symbol for input connection

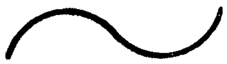
t) Box 13 The type of supply to be indicated from the following symbols:



direct current



rectified current



alternating current preceded by the number of phases and followed by the frequency in Hz

The number of phases of the power mains is to be indicated by the number preceding the symbol example, 1 ~ for single phase alternating current.

u) Box 14 The frequency of the supply mains, for example, 50 Hz

v) Box 15 The supply voltage U_1 volts for which the set is rated to be indicated in this box

w) Box 16 The rating in KVar of the power factor correction capacitor if fitted is to be indicated in this box

x) Box 18 The input current at continuous rating is to be indicated in this box

y) Box 19 The KVar rating at the input current corresponding to Box 18 is to be indicated in this box

z) Box 20, 21 and 22 For additional information, if any.

ANNEX A

(*Clause* 8.8.2)

CALCULATION OF VOLTAGE REGULATION

A-1 The inherent voltage regulation from no load to a load of any assumed value and power factor may be computed from the impedence voltage and corresponding load loss measured with rated current or any other current not less than 50 percent of rated current during the test for load losses and impedance voltage may be computed as 'follows:

I = rated line current of the winding excited,

E = rated no load line to line voltage of winding excited,

I_{sc} = current measured in winding excited,

$E_{z_{sc}}$ = voltage measured across winding excited (impedence voltage),

P_{sc} = watts measured across winding excited,

$E_{x_{sc}}$ = reactance voltage = $\sqrt{E_{z_{sc}}^2 - \left(\frac{P_{sc}}{I_{sc}}\right)^2}$

$P = P_{sc}$ corrected to 75°C and from current I_{sc} to I,

$$E = E_{x_{sc}} \times \frac{I}{I_{sc}} ,$$

$$E_x = \frac{P}{I} ,$$

$$E_x \text{ percent} = 100 \times \frac{E_x}{E} , \text{ and}$$

$$E_r \text{ percent} = 100 \times \frac{E_r}{E}$$

A-2 For rated load and any power factor, Cos ϕ, the percentage regulation is approximately equal to:

$$\text{Cos } \phi \, E_x \text{ percent} + \text{Sin } \phi \, E_r \text{ percent} + \frac{(\text{Cos } \phi \, E_x \text{ percent} - \text{Sin } \phi \, E_r \text{ percent})^2}{200}$$

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Doc : No. ETD 21 (2875)

Amendments Issued Since Publication

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Printed at New India Printing Press, Khurja, India